June 2, 1976

RAD Health/ Land Survey
Brittany Place S/D - Phase I
Bartow, Florida

Mr. D.E. Simpson, Project Engineer
USS Realty Development
Post Office Box 2086
Bartow, Florida 33830

10517186

Dear Mr. Simpson:

I have reviewed the copy of the study. "Environmental Surveillance for Radioactivity, Brittany Place Development, Phase I",which you submitted to this agency for approval to commence construction. First, let me say that the recommended Interim Criteria is just that, a recommendation to be followed if you so desire. This agency or any other agency to my knowledge does not have the authority to approve or disapprove construction based on this criteria. Since the use of gamma radiation levels to predict Radon 222 levels has proven to be highly unreliable, the E.P.A. and the State Radiological Health Unit along with this agency have been working in unison, gathering data utilizing differen radon emanation detection methods in an effort to establish more meaningful criteria. In talking with Dr. Guimond of E.P.A. he feels that possibly by November of this year sufficint data will have been analysed to establish these guidelines.

In reviewing this report it was noted that a point source was used to calibrate the survey instruments. This idea was abandon by both E.P.A. and the state due to the "Slab Effect" of the area being surveyed. Basically all GM survey units are calibrated against a pressurized ion chamber on the site to be surveyed.

Regardless of the content of the survey as presented let me say again that we are not in a position to approve or disapprove your project from the Radiological standpoint since this state has no standards covering natural radioactivity levels. I do appreciat your position in this matter and would be willing to discuss it further should you so desire.

Sincerely,

Donald R. Guthrie, P.E.
Sanitary Engineer

DRG/rch

For: William F. Hill

ENVIRONMENTAL SURVEILLANCE FOR RADIOACTIVITY

BRITTANY PLACE DEVELOPMENT, PHASE I

BARTOW, FLORIDA

Prepared for:

USS REALTY DEVELOPMENT

March 1976

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1.0 EXECUTIVE SUMMARY

In October 1975 the United States Environmental Protection Agency (EPA) published a preliminary report claiming a potentially significant radiation exposure problem involving structures constructed on reclaimed phosphate land. The problem allegedly developed from radon-222 seeping into the structures and the subsequent exposure of residents of the structures to radon-222 and its decay products. As a result of these preliminary findings, EPA scheduled additional studies to establish acceptable radiation level criteria for the structures and to establish a readily measureable parameter which can be used to determine compliance with the radiation level criteria. At the present time, this work is under way.

Rather than impose a complete moratorium on construction until completion of this study, EPA has established interim criteria that will enable screening of proposed construction sites. These criteria were published in January 1976. The interim criteria published by EPA state that if the external gamma radiation level is less than 10 μR/hour, construction may be initiated. If the external gamma radiation level is equal to or greater than 10 μR/hour, EPA recommends that construction be delayed pending additional study or that acceptable control technology be used to preclude indoor radon daughter problems.

USS Realty Development had underway a housing development project in southeast Bartow which was affected by the 1975 EPA findings. In order to determine whether or not the property was suitable for development, based on the interim EPA criteria, USS Realty Development undertook a radiological survey to measure external gamma radiation levels on the site. Measurements made on March 6, 1976 showed external gamma radiation levels between 3 and 16 μR/hour. In general, the gamma radiation levels indicated that the majority of this land is suitable for development. The external gamma radiation levels for the site are presented graphically in Figure 2.

2.0 INTRODUCTION

USS Realty Development had plans underway for the development of property in southeast Bartow, referred to as Brittany Place Phase I, at the time EPA published its preliminary report on radiation exposure problems. In order to determine the suitability of the property for a housing development, based on the radiation criteria published by EPA, USS Realty Development contracted for a radiological survey to determine external gamma radiation levels on the site. The survey was conducted by Sholtes & Koogler, Environmental Consultants (SKEC) of Gainesville, Florida on March 6, 1976. The remainder of this report discusses the radiation problem and the results of the radiological survey.

3.0 RADIOACTIVITY AND PHOSPHATE DEPOSITS

As they occur naturally, radionuclides present in phosphate rock present virtually no problem. The soil overlying the rock is normally 20 to 60 feet thick. This soil provides sufficient shielding to reduce radiation exposure at ground surface to levels which are no higher than background levels normally experienced throughout the United States.

When the phosphate rock has been mined, however, some material containing the radionuclide is mixed with the overburden and, during reclamation, it may be redeposited at or near the ground surface. In other cases, mined land is sometimes reclaimed with by-product materials from the processing of phosphate rock. These materials contain approximately one-third the radioactive materials originally present in the matrix and, if distributed at or near the ground surface, can present a potential for radiation exposure. The problem of elevated radiation levels develops, therefore, when materials containing radionuclides are deposited at or near the surface of the ground during land reclamation.

The radionuclides which create the potential problem are those in the uranium-238 series. The problem identified by EPA is caused specifically by radon-222, the decay product of radium-226. The problem develops when radon-222 is exhaled from the recalimed land, finds its way into residential structures built on the reclai[illegible]d land, and subsequently decays to other non-gaseous radionuclides. These decay products become airborne radioactive particles which can be inhaled and deposited in lung tissue. Because of variations in ventilation rates of dwellings, the concentrations of radionuclides sometimes build up to levels which constitute a radiation exposure problem.

A problem in measuring exposure due to radon and its progeny results due to the fact that survey methods require relatively long exposure time; secondly, because several factors influence the emanation rate of radon from the ground; and, thirdly, because the ventilation rate of air within a structure and, hence, the concentration of radon and its progeny, varies with the use of space heating, air conditioning, and the opening of windows. These factors lead to a variable concentration of radon and its progeny and variations in the ratio of the concentrations to one another.

To overcome these problems in measurement, an approach has been developed which is based upon an empirical relationship between measured external gamma radiation and measured radiation levels resulting from radon and its progeny. Basically, this approach is based on the observed fact that for each level of external gamma radiation, there is an associated exposure resulting from the radioactive decay of radon progeny. Based on limited data available, EPA has developed such a relationship. It has been established that if the external gamma radiation levels are less than 10 μR/hour, there is very low probability that the radon daughter levels in structures built on the land will reach a level of concern. The data presented by EPA justifying these criteria are presented in Figure 1.

4.0 RADIOLOGICAL SURVEY

The basic objective of the radiological survey conducted at Brittany Place was to measure external gamma radiation levels over the entire site and to compare levels with criteria established by EPA in January 1976 to determine whether or not the land would be suitable for ing development.

4.1 Calibration of the Field Instrument

A William B. Johnson model GSM-5 survey meter was calibrated by exposure, at a series of measured distances, to a National Bureau of Standards certified radium-226 needle. The calibration procedure is outlined in detail in Appendix A.

4.2 Field Survey

Since the field survey was designed to develop preliminary data upon which to evaluate the suitability of the site, a survey grid system 100 feet by 100 feet was determined adequate. With this grid, one external gamma radiation level was measured for each 10,000 ft^2 of property. For a detailed site survey, EPA required that one external gamma radiation measurement be made for each 500 ft^2 of property. The grid system was formed by establishing traverse lines running in an east-west direction located 100 feet apart in a north-south direction. Each of these lines was then traversed and an external gamma radiation level measurement was made every 100 feet along the traverse line. The survey grid is shown in Figure 2.

All measurements were made at a distance of one meter above the ground using the William B. Johnson survey meter. Meter reading variations at each point were visually averaged for several seconds. It is estimated that the error bounds for each measurement would present less than ±0.6 μR/hour.

As part of the field survey, a check point was established at the southeast corner of the property to determine whether or not changes in environmental conditions during the time of the field measurements produced changes in background radiation levels. The survey instrument was returned to its location at the beginning, mid-point and end of the field survey. Also, a reading from a radium check source was made on-site to insure calibration of the survey instrument. Measurements made at the check point indicated that conditions were constant throughout the time of the survey.

4.3 Results of the Field Survey

The results of the field survey for external gamma radiation levels at the Brittany Place site are presented graphically in Figure 3. External gamma radiation measurements at each grid point are presented in Table 1.

From Figure 2 it can be seen that the external gamma radiation levels over the majority of the area in the proposed Phase I development are below 10 μR/hour. It was noted during the field survey that areas which had external gamma radiation levels in excess of 10 μR/hour generally had noticeable deposits of pebble phosphate rock on the surface of the ground. Since uranium and other radionuclides are concentrated in the phosphate matrix, the occurrence of this material at the ground surface would result in higher external gamma radiation levels. There is a good possibility that the external gamma radiation levels can be reduced by excavating 1 to 2 feet of surface material and filling with clean soil.

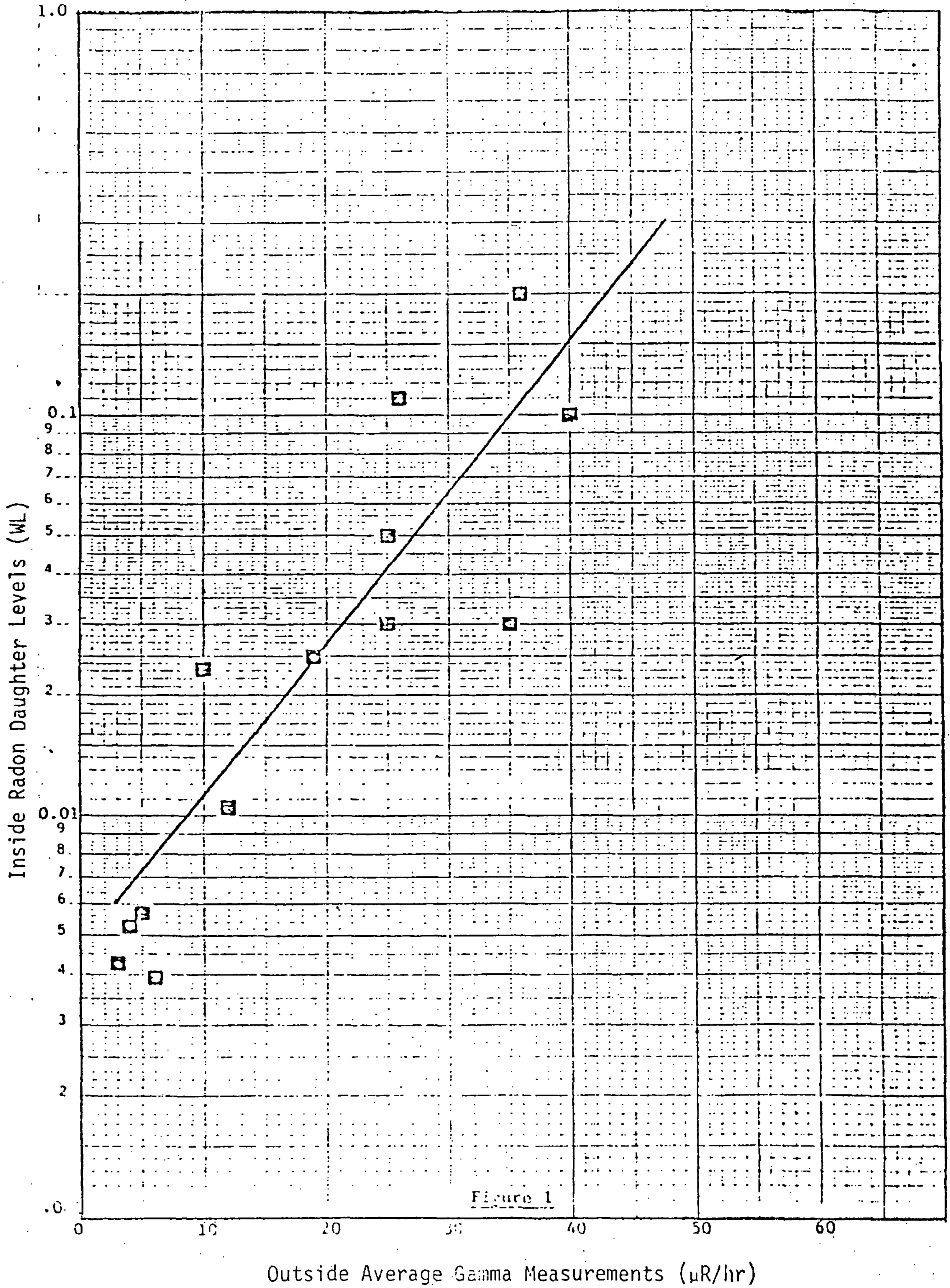

FIGURE 1. OBSERVED RELATIONSHIP OF OUTSIDE AVERAGE GAMMA MEASUREMENTS AND INSIDE RADON DAUGHTER LEVELS (from U.S.E.P.A. Technical Note ORP/CSD-75-4)

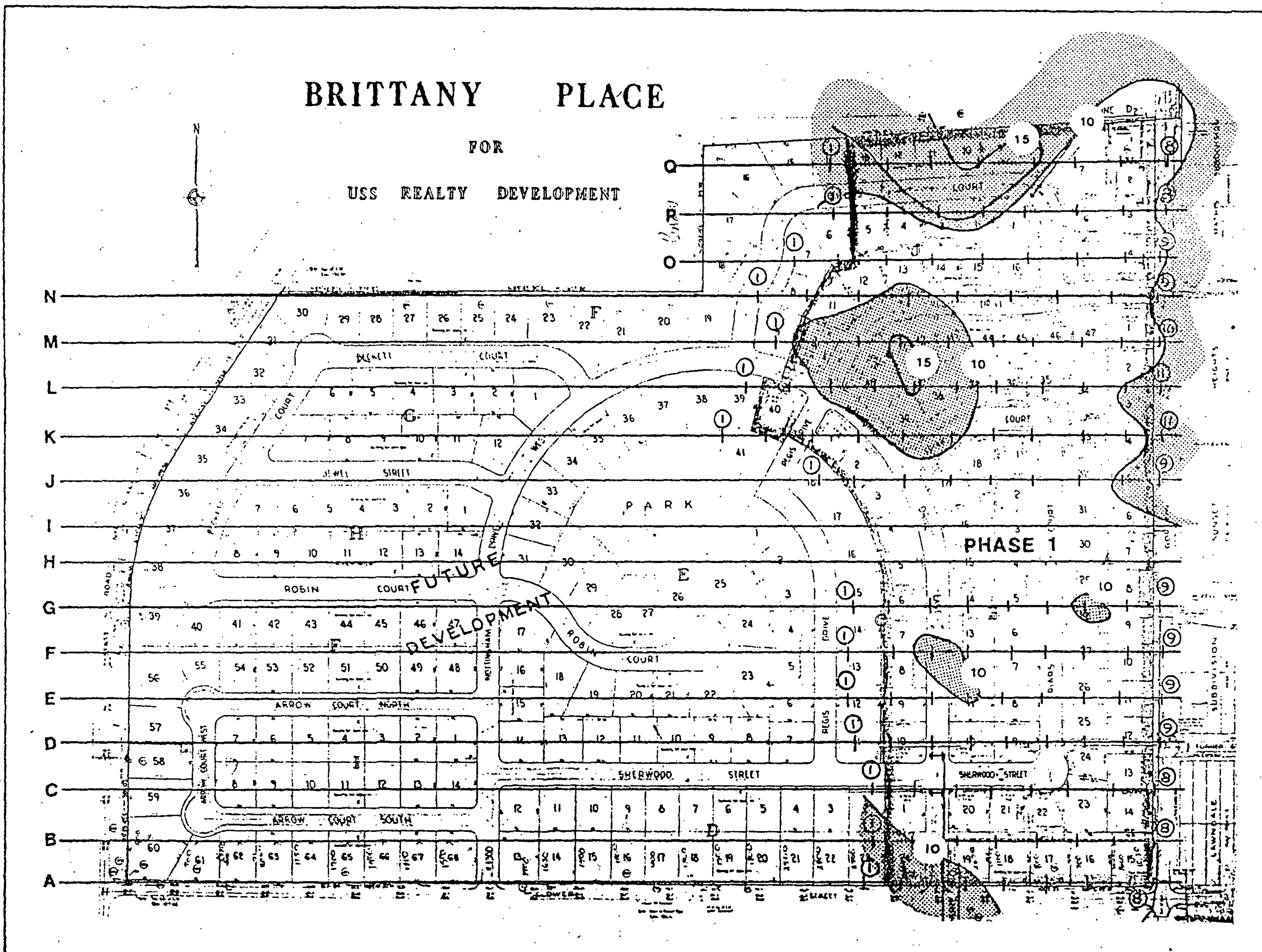

FIGURE 2. SURVEY GRID AND EXTERNAL GAMMA RADIATION LEVELS (μR/hour), BRITTANY PLACE. PHASE I. MARCH 6 1976

TABLE 1. EXTERNAL GAMMA RADIATION LEVELS (μR/hr), BRITTANY PLACE, PHASE I, BARTOW, FLORIDA, MARCH 6, 1976

	Traverse Line														
Point	A	B	C	D	E	F	G	J	K	L	M	N	O	P	Q
1	14.0	12.9	9.0	9.0	9.0	11.2	5.0	3.4	4.5	4.5	9.0	10.1	7.8	8.4	14.8
2	11.8	10.1	8.4	9.0	9.0	9.5	6.2	4.0	3.9	3.9	15.1	9.5	10.1	9.5	15.7
3	9.5	9.5	8.4	9.0	9.5	10.6	7.8	4.0	3.9	14.6	10.1	8.4	7.3	17.6	16.8
4	11.5	9.5	9.5	9.8	10.1	9.5	5.0	4.2	4.5	13.4	15.1	14.0	8.4	15.7	13.4
5	6.2	4.8	3.9	6.4	3.4	5.6	3.9	4.8	11.8	15.7	13.4	5.6	3.9	3.4	19.6
6	4.5	4.5	4.2	3.9	2.8	4.5	3.6	4.0	12.9	11.8	6.7	4.5	5.6	2.8	6.7
7	3.9	3.6	3.4	2.8	2.8	4.5	14.6	4.0	3.9	3.9	3.9	3.9	3.4	9.5	3.9
8	9.0	3.4	3.4	5.0	3.9	8.4	7.8	10.1	3.4	5.0	3.9	9.0	2.8	11.8	4.5
9				5.0	3.1	5.9	5.3	15.1	5.0	3.4	7.8	15.7	7.8		
10									6.2	14.6	9.0				
11									10.1	11.2					

APPENDIX A

Calibration of William B. Johnson, Model GSM-5
Survey Meter (Serial #883) With a Gamma, NAI(TL)
Scintillation Probe, Model GSP (Serial #107)

The standard source and instrument were maintained at 5.5 feet above the ground level using wooden step ladders. The location of the test was immediately east of A. P. Black Hall, University of Florida, Gainesville, Florida where the background appeared to be low and stable. Other response and instrument checks were performed in the laboratory.

The meter of the GSM-5 survey instrument was calibrated and adjusted with a pulse generator. The master calibration control and the internal scale calibrations were adjusted until the linearity of all scales were found to be responding correctly.

Directional dependence of the probe was determined by exposing it at a constant distance from the source in various directions. The response is essentially isotropic with respect to origin of the radiation except for exposure incident on the photomultiplier tube.

The response of the instrument to different gamma energies was determined with an Amersham set (#570) of point gamma sources. Each source was placed 20 cm from the face of the probe and net cpm determined. The system has essentially no response below approximately 0.35 Mev. Efficiencies of approximately 0.17 were obtained with gammas between 0.8 and 1.3 Mev.

The radium source was the needle engraved S/N 0.5-4 from National Bureau of Standards (NBS) Nos. 45647 through 45650. The certificate is available upon request. The NBS calibrated 10 needles <u>in glass</u> and found that they had a gamma radiation equivalent to that from a 4.85 mg of radium. Without the glass container, the equivalent would be 5.2% greater or 5.10 mg radium. Assuming all 10 needles to be of equal strength, S/N 0.5-4 was 0.51 mCi of radium. If Γ for radium with 0.5 mm platinum-irradium case is assumed to be 8.25 cm^2 μR/hr mCi, the attenuation for the additional 0.1 cm pt-irradium would be 2% or for 0.6 cm, the Γ is 8.085. Therefore, S/N 0.5-4 has a strength of 4.12 cm^2 μR/hr (8.085 x 0.51). This is 4.12 x 10^6 μR/hr at one centimeter. All other exposure rates were found by dividing by the square of the distance in centimeters.

The response of the system to the NBS radium needle was noted at distances from 123 cm to 1,216 cm (4'5/8" to 39'11"). When the response curve (exposure vs. meter reading) is linear and intersects a meter reading of zero, several values of added activity and the corresponding changes in meter reading uniquely define the slope of the calibration line. This can be plotted as net meter reading (total reading - background) versus added exposure level (calibrated from needle factors and distance). Any subsequent measurement, including background, can then be converted directly to exposure level.

Field data for the calibration are shown in Table A-1. An analysis of the X100 scale data indicates a slope of 0.0054 μR/hr per cpm. The highest data point (271 μR/hr) was not included since the better fit was achieved, and indicates some additional geometry effects at close range.

Data for the X10 scale produced a slope of 0.0057 μR/hr per cpm. The slope difference in the two scales is 6% and the difference may be entirely random.

The data from both scales were combined by dividing each data set by the scale factor. This produced a plot of points at relative scale deflection. See Figure A-1. These data produce a slope of 0.0056 μR/hr per cpm. This single calibration factor will be used in all measurements with the system.

A check source, consisting of a radium disk source mounted in a modified plastic bottle, was used to determine if the instrument was responding properly when taken into the field. When the instrument is in a relatively low background area, the check source should indicate a reading of approximately 3,000 cpm.

TABLE A-1. CALIBRATION DATA; RADIUM NEEDLE S/N 0.5-4 METER #883 and PROBE #107

Distance (r) Centimeter	Added Activity uR/hr	Instrument		
		Range	Gross, cpm	Net, cpm*
123.4	271	X 100	44,500	43,650
156	170	X 100	31,500	30,650
202	101	X 100	20,000	19,150
272	55.8	X 100	12,000	11,150
462	19.35	X 100	5,200	4,350
462	19.35	X 10	4,150	3,300
591	11.81	X 10	3,100	2,250
761	7.12	X 10	2,200	1,350
1,008	4.05	X 10	1,600	750
1,216	2.79	X 10	1,400	550

* Bkg cpm = 850

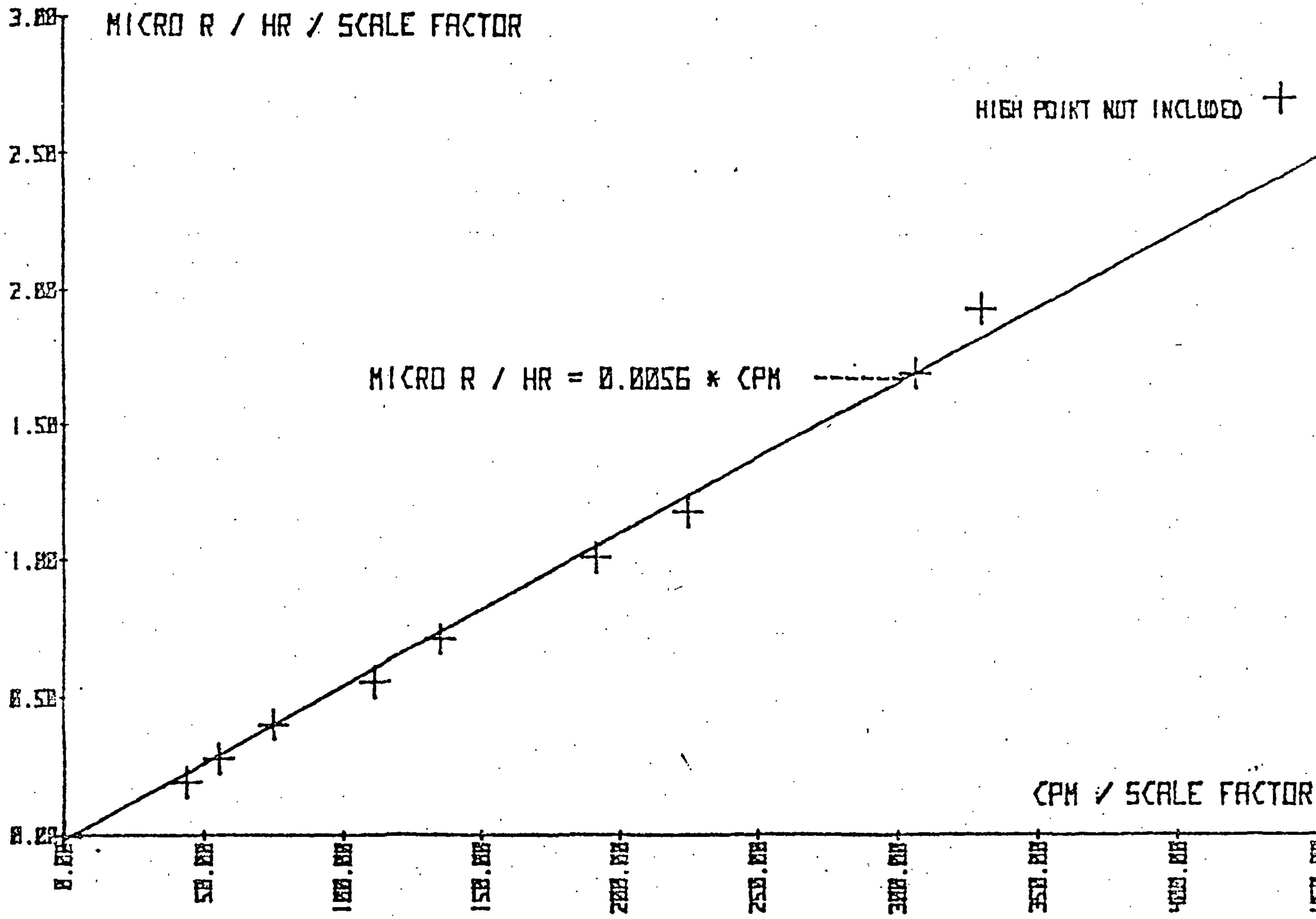

FIGURE A-1. CALIBRATION OF BOTH SCALES, cpm VERSUS EXPOSURE